Calculating the Embodied Carbon Footprint of Marvel's Tony Stark

The building and construction industry is responsible for nearly 40% of global greenhouse gas emissions. Reducing these emissions marks a significant opportunity to reduce global warming and foster a better building future.

What does the impact of these emissions really look like? Let's examine in the context of the billionaire, genius and famous Marvel superhero Iron Man, or Tony Stark. For as smart as he is, we can't help but wonder if he could have thought a bit more about the carbon impact of his extensive building portfolio.

Carbon Impact of Buildings

It's important to first understand that a building releases carbon emissions in two stages: the embodied carbon stage and the operational carbon stage.

- Operational Carbon is defined as the GHGs emitted during the use of a building.
- Embodied Carbon is the carbon footprint of a material and considers all GHGs emitted throughout the product's supply chain, installation, use, replacement and end of life disposal.

While crucial to reduce both emission types, reducing embodied carbon is the most urgent opportunity, as building material manufacturing makes up over 10% of total GHG emissions and, which cannot be reduced over time.

Notably, almost all of Tony Stark's emissions are in the form of embodied carbon.

Tony Stark's Embodied Carbon Emissions

To understand Tony Stark's total carbon footprint for his building portfolio, we looked at three key spaces:

- Stark Tower, the high-rise building complex located in New York City, the main headquarters for the Avengers.
- Malibu Mansion, the modern cliffside mansion that Tony and Pepper share with J.A.R.V.I.S.
- Avengers Compound, the primary base for operations and training for the Avengers.

Out of curiosity, we also estimated the carbon emissions of all of Iron Man's armor since they are made of Titanium Alloy, and we know that manufacturing metals such as this can have a significant embodied carbon impact.

As we looked at the carbon emissions for each space plus the armor, the results were stark, indeed.

Tony Stark's carbon footprint through Avengers: Endgame is **211,587 tons** of carbon dioxide emissions.

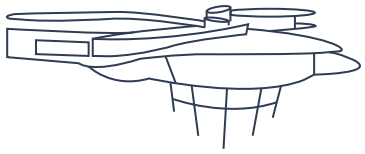
Embodied Carbon
Manufacture, transport and installation of construction materials

Operational Carbon
Building energy consumption

Importantly, none of these emissions are from operational carbon because of Tony's ARC Reactor, which is a source for sustainable energy and powers all these facilities. However, this means that all of Tony's emissions are embodied carbon emissions. Here's the embodied carbon footprint of each facility and his armor:

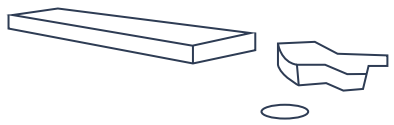
Stark Tower

207,200
tons of carbon dioxide emissions



Malibu Mansion

579
tons of carbon dioxide emissions



Avengers Compound

3,729
tons of carbon dioxide emissions

Armor

79
tons of carbon dioxide emissions

The combined emission of these buildings and armor is equivalent to:

46,016
Cars driven for a single year

489,869
Barrels of oil consumed

25,738,002,637
Smartphones charged

233,863,618
Pounds of coal burned

What This Means for the Real World

Addressing embodied carbon is critical to reduce the global warming potential of our built spaces. Even when Tony Stark used sustainable energy sources, these buildings still pack a significant punch.

If you'd like to learn more about embodied carbon, and the tools and data available to reduce it, please contact Building Transparency, the nonprofit providing open access data and tools to enable broad and swift action across the building industry in addressing embodied carbon's role in climate change.

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